

DESIGN AND IMPLEMENTATION OF INDUCTION HEATER FOR MAINTAINING THE TEMPERATURE OF A RUNNING WATER

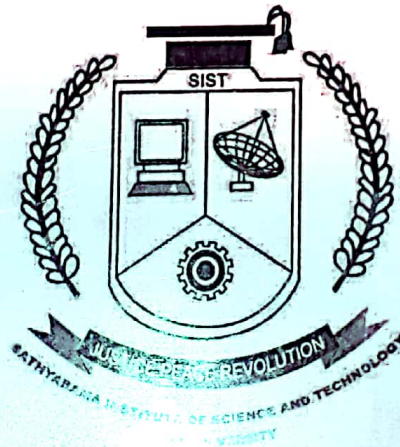
Submitted in partial fulfillment of the requirements for the award of

Bachelor of Engineering Degree in
Electrical and Electronics Engineering

by

PAVITHRA R (Register No. 39140037)

SNEHA D (Register No. 39140053)



DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
SCHOOL OF ELECTRICAL AND ELECTRONICS

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

Accredited with Grade "A" by NAAC
JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

APRIL 2023

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of PAVITHRA R (Reg. No. 39140037) and SNEHA D (Reg. No. 39140053) who carried out the project entitled "DESIGN AND IMPLEMENTATION OF INDUCTION HEATER FOR MAINTAINING THE TEMPERATURE OF A RUNNING WATER" under our supervision from November 2022 to April 2023.

J. Barnabas
26/4/23
Dr. J. BARNABAS PAUL GLADY
Internal Guide

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Internal Examiner

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DECLARATION

We PAVITHRA R (Reg. No. 39140037) and SNEHA D (Reg. No.39140053) hereby declare that the Project Report entitled "DESIGN AND IMPLEMENTATION OF INDUCTION HEATER FOR MAINTANING THE TEMPERATURE OF A RUNNING WATER" done by us under the guidance of Dr.J.BARNABAS PAUL GLADY is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electrical and Electronics Engineering.

1. PAVITHRA.R

2. SNEHA.D

DATE:

PLACE:

SIGNATURE OF THE CANDIDATES

CHAPTER 1

INTRODUCTION

1.1 GENERAL

Induction heating technique has a variety of applications in recent years, including cooking, tight passage, hardening, annealing, welding, and plasma physics. Induction water heaters have been produced in a variety of ways recently. However, those heaters were intended to heat water. Water heating has also been the subject of academic study. Consequently, it appears that an induction water heater system is a helpful invention. The appeal of induction heating is that you may use electricity to directly heat appropriate metals without wasting energy by first creating heat somewhere else and then transferring it to the object you want to heat to use induction heating you would need to use a coil to heat a block of iron which then heated the water. Many of the people suffering without hot water in hospital. For that purpose, this project will really helpful for that people.

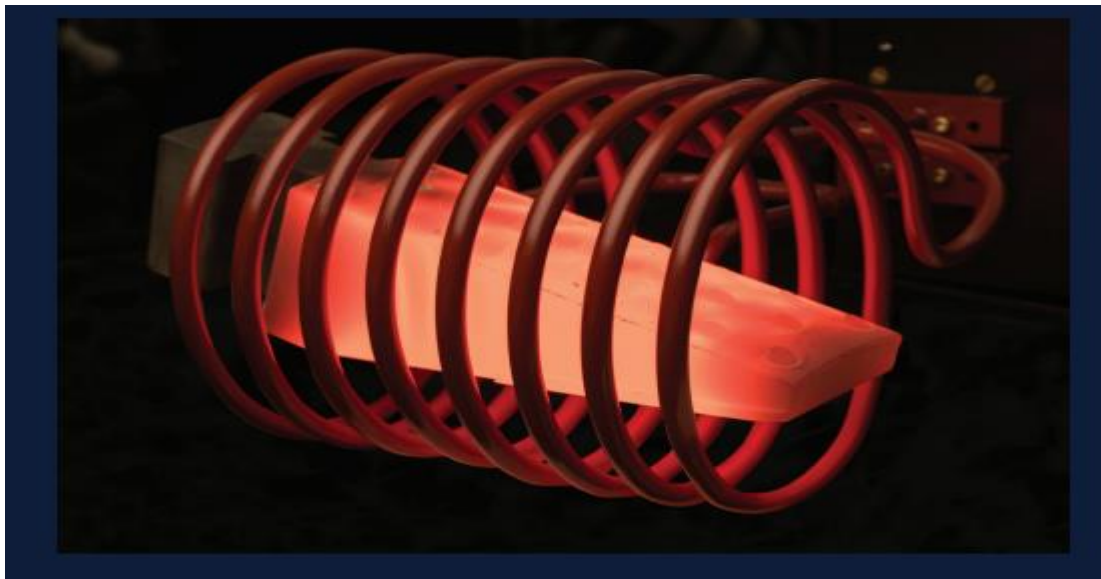


Fig:1.1 : Induction coil

An induction heater is a type of heating device that uses electromagnetic induction to heat metal objects. The principle of induction heating is based on the generation of eddy currents in a metal object when it is placed in a varying magnetic field. These eddy

currents cause the metal to heat up, and the temperature can be controlled by adjusting the intensity and frequency of the magnetic field.

Induction heaters are used in a wide range of applications, including metalworking, heat treating, welding, and cooking. They offer several advantages over other heating methods, such as faster heating rates, precise temperature control, and energy efficiency. Induction heating can also be used for selective heating, which means that only the surface of the metal object is heated, while the core remains relatively cool. Induction heaters come in various shapes and sizes, from small handheld devices to large industrial systems. They can be powered by different sources, such as electricity or gas, and can be designed to meet specific heating requirements. With advancements in technology and materials, induction heaters have become increasingly popular and versatile, making them an important tool in many industries.

1.2 MOTIVATION FOR THE SELECTION OF THE PROJECT

Induction heaters are often selected for their ability to rapidly and efficiently heat conductive materials without direct contact, making them a popular choice in various industries. Some common motivations for selecting an induction heater may include:

- **Efficiency:** Induction heating can be more efficient than other heating methods because it heats only the part of the material that needs to be heated, rather than the entire object. This can result in faster heating times and lower energy consumption.
- **Precision:** Induction heating can be highly precise, allowing for accurate control of temperature and heating profiles. This can be important in applications where temperature control is critical, such as in heat treatment processes.
- **Safety:** Induction heating can be a safer alternative to open-flame heating methods, as it does not produce an open flame and does not require direct contact with the heating element.
- **Cleanliness:** Induction heating can be a clean heating method, as it does not produce combustion by products like soot or ash. This can be important in

applications where cleanliness is critical, such as in the production of electronics or medical devices.

- **Flexibility:** Induction heating can be used to heat a wide range of materials, from metals to ceramics to composites. It can also be used in a variety of applications, such as brazing, annealing, forging, and melting.

1.3 OVERVIEW OF THE PROJECT

An induction heater is an electrical device that uses electromagnetic induction to heat conductive materials. It works by inducing eddy currents, or circular electric currents, in the material being heated, which in turn generates heat. This process is efficient and fast, making induction heating a popular choice in various industrial applications. Induction heaters consist of a power supply that generates high-frequency alternating current (AC) and a coil that surrounds the material being heated. The coil is typically made of copper tubing, and the material being heated is placed within the coil. As the alternating current flows through the coil, it generates a magnetic field that induces eddy currents in the material being heated. These eddy currents cause resistance in the material, which generates heat.

Induction heaters can be used to heat a wide range of materials, including metals, ceramics, and composites. They are commonly used in applications such as brazing, annealing, forging, and melting. Induction heating can be more efficient and precise than other heating methods, and it can be a safer and cleaner alternative to open-flame heating methods. Induction heaters can vary in size and power, from small handheld devices to large industrial systems. They can be used in a variety of industries, including automotive, aerospace, electronics, and manufacturing.

CHAPTER 2

LITERATURE SURVEY

2.1 MAJOR FINDINGS FROM LITERATURE SURVEY

J. Yang et al.,(2014) proposed Design and Experimental Results of a DC Induction Heater Prototype for Aluminium Billets .The benefits of dc induction heating in high efficiency and right heating first-rate were proved and studied international in beyond a long time. on this paper, a laboratory-scale dc induction heater with iron yoke for aluminium billets is designed and examined in detail. The billet to be heated is placed inside the air hole of the yoke and is driven by a motor. The magnetic area in the hole is built up by using copper winding with direct currents. The entire heating strategies under exceptional situations are found. Numerous surface temperature distributions were completed by changing numerous heating parameters inclusive of heating time, rotating pace, and dc magnetic subject. Numerical evaluation for calculating the heating system is likewise completed in an industrial finite-element software. outcomes show that each one the heating parameters will affect the final heating results induction heating has been carried out to preheat metals in particular for non-magnetic billets like aluminium (Al), cupper, or brass earlier than extrusion operations. In conventional induction heaters, the billet is uncovered to the AC subject that's produced with the aid of a water-cooled copper winding. For non-magnetic materials, the efficiency is handiest approximately 50% as 1/2 of the overall strength is transformed into warmth in the copper wingdings and eliminated by means of the cooling water. lately a brand-new DC induction heating concept has been proposed by M. Runde and N. Magnusson. in step with Lenten regulation, currents are brought on in an engaging in loop while the magnetic subject enclosed by means of the loop adjustments. any such exchange in magnetic field can be completed with the aid of rotating the billet in a static or DC magnetic area. M. Fabric and A. Moran has studied the DC induction heating in static magnetic field with the aid of the usage of permanent magnets. And by means of the use of DC superconductive wingdings, the electrical efficiency of the aluminium billet heater ought to increase up to ninety% theoretically. On this paper, the design and experiment consequences of a DC induction heater prototype

for aluminium billets have been offered. numerous surface temperature distributions had been executed in element with the aid of changing numerous parameters consisting of heating time, rotating velocity and DC magnetic subject. The complete heating techniques are found and in comparison, with the numerical model. The effects display that each one the heating time, rotating pace and magnetic flux density will growth the temperature gradient along the axis route of the billet surface. Temperatures don't boom linearly with heating time. because the conductivity value of the aluminium decreases whiles the heat ability fee increases correspondingly with the temperatures however temperatures increase linearly with magnetic flux density and rotating pace in our tool. due to the fact the radius of the billet used isn't always big sufficient relative to the skin depth and consequently the centre of the billet is heated quick. Temperature distributions at the floor of the billet agree well with the simulation effects. all the disparities are about 10% below one-of-a-kind experiment conditions. The experience obtained inside the layout and test of the DC induction heater prototype could be used for designing the better strength excessive-temperature superconductors (HTS)induction heater. The copper coils will be replaced by way of HTS windings and the iron yoke may be redesigned for larger billets

Stvan N. Veber et al.,(2019) international conference on Engineering of modern Electric System proposed Design and Implementation of a Low Power Induction Heater The paper is focused at the realistic consciousness of a low strength induction heater with widely available additives, for the cause of reading the phenomena of heating the usage of electromagnetic fields and the manner to generate it .keywords electromagnetic induction, induct-or, inductive heating, energy converter. The principle of induction heating is producing an electromagnetic subject that reasons the work piece to warmth up from the eddy currents produced in it. An essential feature is that the heating is produced within the metallic item without any outside warmness supply. additionally, the work-coil can be made in different shapes and sizes to not to warmth up the whole piece. At the start, the first steps had been made with a simpler model, the ZVS type. After that became found out one larger, with greater electricity. presently it has no comments or protection system, just the fuses in case of failure. inside the future it is going to be brought some protection structures and a water-cooling system.

Hisayuki Sugimura et al., (2008) conference prepare proposed Direct AC-AC Resonant Converter using One Chip Reverse Blocking IGBT-Based Bidirectional Switches for HF Induction Heaters. This paper deals with a novel type gentle switching application frequency AC- excessive frequency AC converter the use of asymmetrical PWM bidirectional active switches that can be described as high frequency resonant matrix converter. This power frequency changer can immediately convert software frequency AC power to high frequency AC power ranging extra than 20kHz as much as 100kHz. best one energetic edge resonant capacitor-assisted tender switching high frequency load resonant Cycle converter is based on asymmetrical obligation cycle PWM approach. This high frequency cycle-converter uses bidirectional IGBT composed of anti-parallel one-chip reverse blocking off IGBT. This excessive frequency cycle converter has some awesome features as electrolytic capacitor less DC bus line hyperlink, team spirit power element correction and sine wave line modern shaping, easy configuration with minimal circuit additives and low fee, high performance and downsizing. This series load resonant cycle converter incorporating bidirectional lively power switches is developed and carried out for high performance patron induction heated meals cooking home equipment. Its operating principle is described through the use of equal circuits. Its running performances as gentle switching operating stages and high frequency powerful strength regulation characteristics are discussed on the basis of simulation and experimental outcomes. Index phrases Bidirectional switches, Direct strength frequency conversion, high frequency PWM cycle converter, tender switching commutation, Induction heating, One-chip reverse blocking IGBT .In current years, the high frequency tender switching electricity conversion circuits (excessive frequency inverters, high frequency switching DC-DC converters) technology make a contribution for effective domestic and commercial power packages. The overall performance enhancement, strength saving and downsizing for the domestic electric powered electricity home equipment have been proceeded with high-quality advances of energy semiconductor devices and passive circuit additives. The high frequency inverter circuits have had been actively promoted to date that research and improvement on high frequency power conversion technologies for the excessive frequency induction heating. Electromagnetic induction heating implemented technology in domestic and business usages were

spotlighted in attractive induction heating appliances as metallic operating manner, warmth remedy, dissolution method, induction heating soldering with the self-temperature characteristic magnetic alloy heating detail, induction fusion of polyethylene pipe, IH rice cooker, IH boiler, IH warm-water provider, IH flyer and superheated vapor steamer by using the country-of-the art IH fluid heating strategies. The trends on the modern-day electric powered kitchen systems with benefits as simple, reliability, protection, upkeep unfastened, efficiency development of the meals cooking and processing paintings, and reduction in general running cost have attracted special hobby in present day society. From these viewpoints, the development of excessive frequency electricity deliver home equipment for kitchen equipment and centers are required increasingly. The improvement of the brand-new high frequency induction heating cooker, boiler and superb heated steamer, that is excessive-performance, high power density and excessive-performance in comparison with the traditional gas cooking equipment are plenty extra appealing for domestic and commercial enterprise makes use of. by way of such technological historical past, excessive-frequency tender switching strength deliver for the electromagnetic induction heating has been developed as well as these manage schemes. This paper proposes high frequency PWM cyclese converter defined because the UFAC to HFAC direct strength frequency changer the usage of bidirectional power semiconductor switching devices based on one chip opposite blocking IGBT anti-parallel connection. The operation precept of the gentle switching excessive frequency cyclee-converter handled right here is described by the usage of switching equal circuits. furthermore, its circuit performance characteristics on the basis of simulation and experimental results are illustrated herein. This paper proposed the radical prototype of one degree voltage-kind multi-resonant sepsis PMW high frequency AC energy conversion circuit operated as the resonant high frequency PWM cycle-converter (resonant high frequency matrix converter) the use of the antiparallel one chip reverse blockading IGBT type bidirectional switches for purchaser induction heating home equipment. The tender switching PWM resonant high frequency cycle converter discussed in operation principle and energy regulation characteristics on the idea of simulation and experimental information. inside the future, the real efficiency and conventional performance traits should be evaluated for resonant high frequency cycle-converter the usage of bidirectional switches. The most

beneficial circuit layout technique of the application AC input clears out part of the resonant high frequency soft switching cycle-converter handled right here should be investigated from a practical factor of view.

Jongho Choi et al., (2019) Conference paper proposed Commercial Design and Operating Characteristics 300 kW Superconducting Induction Heater (SIH). Based on HTS Magnets. Super coil enterprise Ltd. has commercialized a three hundred-okay W-high-Tc-based superconducting induction heater (SIH). Super coil has many patents related to the SIH in addition to technologies to maintain thermal stability and reliability inside the operation of a high-TC superconducting magnet towards choppy quench via the steel insulation winding approach. right here, excessive-temperature superconducting (HTS) magnets had been installed with the 2 iron cores. The configuration of the three hundred-kW SIH changed into added. The heating simulation consequences of the numerous metal billets were shown through the temperature distribution of the billet. operating consequences of the HTS magnets, along with the terminal voltages, excitation cutting-edge, magnetic flux density, and magnet temperature, are supplied and shown. thru these consequences, metal industries advantage gets right of entry to SIH reference data. Index terms—Induction heating, steel insulation, HTS magnet, metal industries, superconducting induction heater. The superconducting induction heater (SIH), a machine preheating merchandise product of extrusion and forging strategies, is in most cases used for diverse varieties of metals. industries, there are many problems in opposition to the implementation of conventional heaters. First, the authorities recently accomplished an environmental safety coverage towards CO₂ emissions.^{2d}, industries use old and inefficient technologies for heating metals with massive potential and low efficiency. One of the solutions to remedy those problems is the SIH with high efficiency, which can be applied to warmth any modern-carrying out cloth, which includes both non-ferrous and ferrous metals, such as aluminium, copper and brass, magnesium, titanium alloys, stainless steel, and ferrous carbon metal. The economic SIH turned into designed and synthetic through Super coil Co. Ltd. in Korea. An excitation and over cutting-edge assessments of the HTS magnets with iron cores have been carried out, and the results have been analysed in distinctive. The operational traits of the HTS magnets together with the cryogenic cooling gadget, including temperatures as well as

the SIH, were offered with actual-time size graphs. The heating operational effects for the STS metal billets had been simulated and the effect have been supplied and in comparison. The steel industries can now get admission to the reference statistics of the SIH thru this paper.

Yu. A. Nikitin et al., (2020) conference paper proposed Research of the Temperature In the Check Valve Zone During Local Induction Heating of Pipeline Valves In the Multi physics Application Package. The features of induction nearby heating of hassle areas of pipeline fittings of oil and gas wells containing a check valve to temperatures that do not exceed safe values and offer a targeted technological mode of operation of the nicely are taken into consideration. A simulation of thermal methods within the COMSOL Multi physics application package become executed with a view to verify the portability of the check valve at one-of-a-kind places of the induction heater relative to the check valve and extraordinary styles of induct-or used for heating. The simulation results affirm the effectiveness of the use of induction heating of nearby zones to keep the operation of the check valve. it's far proven that for a tee valve, the maximum ideal is the use of an induction heater positioned on the annulus line of an oil and gas nicely, and the maximum energy efficient is an induction heater with a local induct-or built into the body. key phrases Induction heating, take a look at valve, simulation. In wintry weather, due to the have an effect on of low temperatures and pressure differences within the pipelines of oil and gasoline wellhead fittings, the take a look at valve of the pipeline fittings regularly freezes, which results in a contravention of the technological process used, as an instance, while pumping or extracting borehole fluid, leading to losses in the production of petrol um products. based on the developed mathematical model of thermal approaches the usage of the Colom Multi physics package, it's far shown that the temperature distribution in the test valve corresponds to the required parameters for heating strength and temperature situations within the heating area, which prevents freezing of the take a look at valve, ensuring its penetrability .It became determined that for a test valve positioned on the junction of the annular and float strains, the maximum applicable is the use of an induction heater positioned at the branch pipe of the annulus line of an oil and gas properly, and the most energy efficient is an induction heater with a neigh induct-or constructed in to the frame.

Pradeep Vishnuram et al.,(2020) conference paper proposed A comprehensive overview of power converter typologies for induction heating applications .Due to its homogeneous heating, lack of pollutants, and increased power density, induction heating is steadily gaining traction. Energy-efficient technologies must be developed in order to achieve these characteristics convincingly in reality. converter typologies that assist in establishing gentle switching power regulation and extremely high frequency use. This essay highlights the key characteristics of converters used in home and commercial heating concentrating on its stage-by-stage power conversion, power density, and load handling size, smooth switching, capacity, and dependability. This topological performance is evaluated in terms of efficiency, flicker, user performance, power rating, modulation approaches, and converter switching frequency. Furthermore, this review article forecasts upcoming patterns related to the adoption of widespread in-band power .The popular induction heating (IH) technology has replaced traditional heating methods because they are safer, non-contact, don't contaminate materials, emit no pollutants, and are more compact .The attractive converter typologies with durability, high efficiency, high power density, smooth power control, low switching loss, multi-load handling capability, and high reliability are required by commercial induction heating systems. High-frequency converter performance must satisfy user requirements and industry norms. In light of taking into account both load handling capability and power stages, a thorough examination of converter typologies is covered in detail. A discussion of IH load modelling and coil selection is presented at first sight. For a single load, a review of two-stage power converter typologies is conducted. These are the fundamental typologies for creating new heating technologies. Significant characteristics and restrictions of numerous unique typologies have also been described.

Pablo Guillen, Héctor Sarnago et_al., (2018) conference paper proposed Asymmetrical Modulation Strategies for Partially Covered Inductors in Flexible Induction Heating Appliances. Flexible surfaces for induction heating appliances are being developed with the use of cost-effective multi-output resonant inverter typologies. such typologies provide many difficulties when applied on a variety of IH loads concurrently. This study examines two asymmetrical Modulations are suggested as a substitute for control output strength The suggested strategy has been examined using and prototype

experiment with two induction heating loads up to 3.6 kW with controllable output power across the whole working range. Induction heating (IH) is the bottom technology for a wide variety of industrial, home, and biomedical applications. Inside the home vicinity, those structures showcase outstanding benefits in phrases of efficiency, protection, cleanliness, and speedy heating that has allowed this generation to end up the main one within the remaining decade. In this context, design tendencies on induction heating home equipment are leading in the direction of greater bendy surfaces with the purpose of enhancing the consumer enjoy. This growth of flexibility allows the usage of a variable variety of pots independently in their form or length over the cook top, being the induct-or activation selected by the tool [3].

which will lay out and enforce such systems, several demanding situations ought to be faced, being the most applicable ones: The layout of small instructors with low mutual coupling, the development of multi-output strength converter, and the control of a high wide variety of masses those demanding situations have to be solved accomplishing a balance between complexity, cost, and overall performance. Induct-or distribution on bendy surfaces is designed to reach huge range of pot positions, satisfying, at least, all of the classical hob positions. but, the absence of restrictions for positioning prevents the final user from being aware about most reliable positions for elevated induct-or coverage. This ends in in part protected instructors with exceptional coupling between the induct-or and the pot and, therefore, one of a kind provided energy, which results in an uneven heating of the pan. On this paper, asymmetrical conduction mode techniques have been provided so that it will offer shared frequency independent energy manipulate for induction cook tops. the primary is based totally on retarded low facet transistor activation while the latter is based on anticipated deactivation latest the transistor. Each obtain complete electricity manipulate over the burden while keeping the switching frequency and may be used in combination to offer a better present day consumption or stability electricity losses between the 1/2 bridge transistors. The proposed strategies have been experimentally validated and compared with previous modulation strategies. As a conclusion, the proposed asymmetrical modulation approach primarily based on expected low facet transistor deactivation acquire reduced losses outperforming classical obligation variation.

Oscar Lucía et al., (2014) conference paper proposed Induction Heating Technology and Its Applications. Past Developments, Current Technology, and Future Challenges Induction heating (IH) era is these days the heating era of choice in many industrial, domestic, and medical packages because of its blessings regarding performance fast heating, safety, cleanness, and accurate manipulate. Advances in key technologies, i.e., electricity electronics, control strategies, and magnetic thing layout, have allowed the development of exceedingly dependable and price-effective structures, making this era quite simply available and ubiquitous. This paper reviews IH technology summarizing the principal milestones in its improvement and analysing the present-day state of art of IH systems in commercial, home, and medical packages, paying unique interest to the key enabling technology concerned. in the end, an overview of destiny studies trends and challenges is given, highlighting the promising future of IH technology. Induction heater (IH) provides contact less, fast, and green heating of conductive substances. it is becoming one of the preferred heating technologies in business, home and clinical application, among other programs, due to its benefits while as compared with different classical heating strategies such as flame heating, resistance heating, or traditional ovens or furnaces. An ac source is used to supply an alternating voltage to an IH coil. The coil generates an alternating magnetic field, wherein the induction goal, i.e., the load, is immersed. therefore, the induction target is heated by using two physicals. This paper has reviewed the contemporary country of artwork of IH structures, focusing at the permitting technology worried and the main applications, and providing an exhaustive list of papers. From a layout point of view, there are three essential allowing technology to tackle when designing an IH machine: strength converter, modulation and manage structure, and the induct-or design. considerable studies have been performed in current years leading to improved IH structures which have enabled widening IH systems utilization to many commercial, home, and clinical packages. The future of IH structures is promising, with new technologies sand applications fostering research in every one of the three allowing technologies aforementioned. The improvement of higher performance and overall performance IH systems is anticipated to be the focus of industrial hobby and researches, similarly increasing the overall interest in IH system.

Ordoñez Flores Rafael et al., (2013) conference paper proposed water heater by magnetic induction. The era within engineering has carry out a type of innovations that answer and solve social, monetary and environment issues. The water heater by means of magnetic induction is a new tool that is proposed to heat the bathe water as it obeys the immoderate water wasting in the course of this pastime, so it anticipates a water and gasoline saving. The suggestion is characterized by way of its sustainability, environmental effect and economy, that would include the special social popularity pleasing the these days wishes. This water heater consumes much less electrical energy than the resistance based totally boiler and it doesn't save warm water and that is why it makes use of much less energy than the fuel based boilers and as a consequence, saving both the energy and the economy .these days the scientific and technology community has gotten worried approximately the data as the fuel burning, petroleum spreads, tree felling, mistaken water use, the excessive quantity, among some other statistics that have affected and changed the herbal surroundings, vegetation, fauna and the million humans fitness. A tangible phenomenon is the planet's global warming due to a high CO₂, methane, among different products of the referred to element's degrees. It has also been a continuously subject the saving and other assets like water, attached to this work hobby. Induction heater is completely unique tool this is the result of innovation and sustainable improvement, which has as goal to solve environmental and active issues.

Luis F. Queued et al (2016) conference paper proposed Design and Testing of To Coil for Induction Water Heater. based totally at the trade of the productive and lively matrix of Ecuador, that consist in the substitution of liquid fuel coming from black oil for energy to cook dinner meals and water heating for human use in residential areas, a prototype Coil (TC)for a water heater Magnetic Induction (MI) is provided on this article. Its operation is rooted in an inverter DC-AC in Sinusoidal Pulse Width Modulation (SPWM) used for using excessive frequency waves through the winding of the coil, producing resistive losses transmitting warmth to the hydraulic fluid the moment that this fluid gets in contact with the core coil the ferromagnetic implemented .This manner it's far insured the most heat switch, showing that the magnetic fields generated with the aid of this prototype are within the standards issued by way of the ministry of surroundings

concerning the tiers of electromagnetic fields to which human beings is uncovered in this situation due to the fields produced via the TC.

Vadim S. Tynchenko et al (2018) conference paper proposed Automated Induction Heating System for Diffusion Welding The paper discusses the diffusion welding installation's creation of an automated control system for induction heating. The automated system area application refers to the procedures for creating stable joints in business in space. The automated system's purpose is to manage supplying warmth and cooling for the using the induction generator during diffusion welding of the product. The offer change of messages with the operator's panel OSV IP320 allowing the operator to keep an eye on the welding operation. The graph of the temperature change is shown on the panel screen. The current temperature of the part and the present state of the procedure generator output in terms of power. The control panel is aRS-485 interface-connected to the controller. The system also offers a chance to change the parameters of the regulatory mechanisms, which enables the execution processing of welding technology. You may be able to save the results of the welding are presented as text and graphic files. Keywords induction, space industry, and diffusion welding Homogeneous and heterogeneous structural metals, as well as their alloys and refractory metallic

J. Acero, J.M. Burdio et al (2008) conference paper proposed The domestic induction heating appliance an overview of recent research. in this paper several studies topics referring to the design and modeling of domestic induction appliances are reviewed. every subject matter is summarized, stressing its most large advances and pointing to its future inclinations. A showing a number of the published papers during the last years is included. The emphases and relative contributions of a number of them are also mentioned. Its overall performance and Its improvement troubles" [1] turned thirty 5 of its publishing, being one of the earliest references at the domestic induction heating field. at some stage in those years, the domestic induction hobs were turning more famous, because of its unique capabilities of safety, cleanliness, short warming and excessive performance. a number of the derive of the fact that the heating is directly generated inside the vessel, in contrast to the traditional contact heating strategies. Mainly, the later feature is attracting the eye searchers dedicated to fairly efficient power electronic systems. Induction cookers represent the domestic application of the induction

heating phenomena. In such devices, the favored heating is produced in metallic vessels by using a various magnetic discipline, which in its flip is generated by means of a planar coil fed by way of electronics inverter. basically, a home induction association consists of a planar flip winding located underneath as vessel and provided by way of a medium-frequency energy supply, normally operated among 20 kHz and one hundred kHz. therefore, domestic induction heating home equipment encompass a form of technology traditionally grouped in converters, virtual control and magnetic additives. On this paper a number of the latest research carried out in those subjects is reviewed, as well as a few super milestones considering publishing are listed. The paper is prepared as follows. section II introduces number of the heritage concepts and current advances about the electricity converters utilized in induction hobs. section the studies dispositions inside the virtual controller in such home equipment. phase IV summarizes the ideas involved within the planar winding's layout, and ultimately segment V attracts conclusions and future inclinations. The goal of this paper has been to present the recent studies on some of the subjects encompassed in an induction heating appliance like inverters, digital manipulate and instructor. These days, induction hobs have grown to be an advanced tool however it's miles gradually appreciated through a growing variety of customers. however, greater research and improvement effort continues to bees in a few factors: the performance of the strength the electronic degrees nonetheless can be upgraded with the aid of reduction of the diode rectifier losses. For this purpose, direct AC/AC conversion may want to constitute an exciting alternative. On digital controllers, machine on Chip implementations is being evaluated as a way to lessen peripheral additives. The reduction of induct-or losses and the design of instructors developing a uniform heating profile are nonetheless pending challenges. eventually, it is still essential an effort to lessen purchaser fee without sacrificing performance and reliability.

H.Gao,Y. Wang et al (2015) conference paper proposed Heating Characteristics of a HTS DC Induction Heater for Aluminum Billets The heating procedure of aluminum billets requires controllable temperature distributions and excessive efficiency. as compared with conventional ac induction warmers, the high temperature superconductor (HTS) dc induction heater has blessings of power saving and higher heating excellent. in this paper, a HTS magnet is designed to obtain controllable temperature distribution for

dc induction heater. A C-fashioned iron yoke is used to split HTS coils and billets. An aluminum billet is circled in the air gap of the C-shaped magnet. Magnetic subject distribution may be changed through adjusting width of the air hole. therefore, the temperature gradient in axial path is controllable. A dc induction heater prototype using this layout is fabricated and its heating traits are examined. A numerical version is built to simulate heating process and temperature distributions of aluminum billet. numerous uniform and gradient temperature distributions of a billet are measured and compared with numerical outcomes. Induction heating for non-magnetic billets like aluminum has been widely used earlier than extrusion. The billet is typically heated in AC or DC magnetic discipline. Conventional AC induction heater produces AC magnetic field and heat. Copper coils are frequently used to produce the field. But the efficiency of traditional AC warmers is most effective approximately 50%. nearly half of the input power is transferred to the copper coils. The principle of DC induction heater is similar to conventional heater. Non-magnetic billet is rotated in a traverse DC magnetic subject produced with the aid of HTS coils with iron yoke absolutely HTS coils, or everlasting magnets [5]–[8]. of DC induction heater may be more than eighty% because of the usage of HTS coils. A full-scale industrial super conducting induction heater has been used in an aluminum extrusion plant. on this paper, a HTS magnet with adjustable iron yoke for DC induction heater is proposed to control temperature distributions in axial path of aluminum billets. A laboratory-scale heater prototype the usage of copper coils is constructed to check the heating characteristics of the designed magnet. Diverse uniform and gradient temperature distributions are finished underneath distinct heating conditions. Temperature contractility of the prototype is proven. results display that surface temperature gradient can be managed via rotation pace, most magnetic flux density, and magnetic field gradient. The gradient is specifically in proportion to magnetic discipline gradient in axial course. The temperature gradient additionally with rotation pace and maximum magnetic flux density. The measured temperature distributions agree properly with the numerical results. V-shaped axial magnetic subject is needed to achieve a uniform temperature distribution within the axial direction. Low heating performance of the prototype is mainly caused by Joule loss on copper coils and thermal loss on aluminum billet. DC induction heater using HTS coils can reach a lot better efficiency.

Iiro Hiltunen et.al., (2005) conference paper proposed Solenoid Bi-2223/Ag Induction Heater for Aluminum and Copper Billets summary—Induction heating is broadly used to warm up aluminum and copper billets before extrusion. Resistive induction heating systems, which usually have the total efficiency of 50–60%, are generally used with ac cutting-edge. via utilizing superconductivity, the full efficiency of induction heating device may be improved to approximately 90%. If the heating electricity of conventional induction heaters may be reached with a superconducting tool, resistive systems should be replaced via superconducting ones, and extraordinary savings could develop in the long run. on this paper the Bi-2223/Ag induction heater is studied. A solenoid magnet for induction heating of aluminum and copper billets is designed. Ac losses are a massive hassle in Bi-2223/Ag magnets. for this reason, dc contemporary is applied and the eddy currents are generated by rotating the billets. Coil design aimed to maximize the heating power by way of maximizing the radial gradient of the magnetic flux density in the heating place. inside the layout method the optimization set of rules Sequential Quadratic Programming become coupled with electromagnetic discipline computation by using Finite element method. The quench current of the coil become decided based on the stable evaluation of conduction-cooled Bi-2223/Ag magnets. while resistive electromagnets are applied in induction heating of aluminum and copper billets, the overall efficiency of the gadget normally stays at 50–60%. because the operation of these devices is generally non-stop, a boom in performance may want to result in widespread financial savings in the long run. The heating impact of an induction heating machine is because of eddy currents in the object induced with the aid of the converting magnetic field. Whilst-resistive electromagnets are used, the changing magnetic subject is created through ac current supplied in the coil. If the resistive electromagnets of this kind of system are changed by means of superconducting ones, ac losses of the superconductor limit the increase of the whole efficiency. The trouble is emphasized in Bi-primarily based HTS materials, which have extremely good losses in ac use [1]. however, if dc cutting-edge is used, superconducting coils of an induction heating system may be taken into consideration practically lossless. those types of devices, in which the induction heating coils are provided with dc contemporary, have already been delivered via sintef in Norway [2]. on this paper the feasibility of adenoidal Bi-2223/Ag coil in dc induction heating system

is investigated at special operation temperatures. The feasibility of adenoial Bi-2223/Ag coil in induction heating device was studied. In business systems, which make use of resistive electromagnets, the total performance is generally 50–60%. The idea of utilizing superconductivity is to increase the whole efficiency to the location of 90%. The idea of induction heating is based on the changing magnetic subject, which induces eddy currents inside the item under heating. Industrial structures make use of ac modern. Resistive magnets in the sort of machine can't get replaced with superconducting ones because of giant ac losses of the superconductor. a good way to attain the efficiency target of ninety%, dc modern ought to be used. in this papers the feasibility of adenoial Bi-2223/Ag coil in induction heating system changed into studied. The coil become supplied with dc present day, and the changing magnetic subject required for the heating effect become created via rotating the billets. which will maximize the heating strength by using the manner of coil design, the object characteristic inside the optimization process was the radial gradient of the magnetic flux density over the billet diameter. The optimization set of rules of Sequential Quadratic Programming become used. The magnetic flux density distributions were computed with Finite element technique. in keeping with these initial effects, a Bi-2223/Ag coils able to produce enough heating strength a good way to compete with industrial induction heating structures. however, be reason this paper targeted on magnet design, the computations of heating electricity and temperature of the billet have been best approximation. A correct determination of the distribution of those portions calls for a numerical approach. furthermore, convective and radiate heat switch have to be taken into consideration at the same time as computing the temperature of the billet. however, induction heating seems to be a promising software place for superconductivity in the destiny.

2.2 INFERENCE FROM THE LITERATURE SURVEY

The inference of an induction heater is that it is an efficient, fast, and precise method of heating conductive materials using electromagnetic induction. The device consists of a power supply that generates high-frequency AC and a coil that surrounds the material being heated. When the AC flows through the coil, it creates a magnetic field that induces eddy currents in the material, generating heat due to resistance. This heating method is

commonly used in various industries, including automotive, aerospace, electronics, and manufacturing, for applications such as brazing, annealing, forging, and melting. Induction heating is considered to be safer and cleaner than open-flame heating methods and can be used to heat a wide range of materials, making it a versatile technology. The coil is typically made of copper tubing, and the material being heated is placed within the coil. As the AC flows through the coil, it generates a magnetic field that induces eddy currents in the material being heated. These eddy currents cause resistance in the material, which generates heat. Induction heaters can be used to heat a wide range of materials, including metals, ceramics, and composites. They are commonly used in various industrial applications, such as brazing, annealing, forging, and melting, due to their efficiency, speed, and precision. Induction heating is considered to be a safer and cleaner alternative to open-flame heating methods. Induction heaters come in various sizes and power levels, from small handheld devices to large industrial systems. They can be used in a variety of industries, including automotive, aerospace, electronics, and manufacturing.

2.3 PROBLEM IDENTIFICATION

The problem identified for the design and implementation of an induction heater for maintaining the temperature of running water is the need for an efficient, precise, and safe heating solution for various applications. Traditional water heating methods, such as electric resistance heaters or gas heaters, can lead to significant energy loss and may not be suitable for certain applications, such as heating water in a continuous flow system. An induction heater can offer a more efficient and precise heating solution for maintaining the temperature of running water. However, designing and implementing an induction heater for this purpose requires addressing specific challenges, such as ensuring the heater can handle the flow rate and volume of the water, controlling the temperature accurately, and ensuring the safety of the system. Moreover, the design must be cost-effective and durable, taking into consideration the maintenance and operational requirements. Continuous hot water is not available. Reliable Energy based induction heating for water heating.

2.4 AIM OF THE PROJECT

The aim of the design and implementation of an induction heater for maintaining the temperature of running water is to provide an efficient, precise, and safe heating solution for various applications. The induction heater should be able to handle the flow rate and volume of the water, control the temperature accurately, and be cost-effective and durable in terms of maintenance and operational requirements. The design should also take into consideration the safety of the system, including the prevention of electric shocks, overheating, and other hazards. Ultimately, the goal is to provide a reliable and sustainable heating solution for maintaining the temperature of running water that meets the specific needs of the intended application. It is to efficiently and accurately heat conductive materials using electromagnetic induction. The device should be able to generate a magnetic field that induces eddy currents in the material being heated, generating heat due to resistance. Induction heaters can be used in various industrial applications, such as brazing, annealing, forging, and melting, to provide a fast, precise, and efficient heating solution. The design and implementation of an induction heater should also take into consideration factors such as safety, cost-effectiveness, and durability.

2.5 SCOPE OF THE PROJECT

The scope of the design and implementation of an induction heater for maintaining the temperature of running water includes:

- 1.Determining the specific requirements of the application, such as the flow rate, volume, and temperature range of the water.
- 1.Selecting appropriate components, such as the power supply, coil, and control system, based on the requirements of the application.
- Designing the induction heater system, including the coil, control system, and safety features.
- Prototyping and testing the induction heater to ensure it meets the specific requirements of the application and is safe and reliable to use.
- Optimizing the design for efficiency, cost-effectiveness, and durability.

- Developing the final product, including documentation and user manuals.
- Providing ongoing maintenance and support to ensure the longevity and reliability of the induction heater system.

The scope of the design and implementation may also include ensuring compliance with relevant safety standards and regulations. The specific scope may vary depending on the intended application and the requirements of the client or end-user.

2.6 METHODOLOGY

The methodology for designing an induction heater involves several steps. Here's a general overview:

- Determine the heating requirements: The first step is to determine the specific requirements for the heating application. This includes the type of material being heated, the required heating temperature, the size and shape of the material, and the desired heating rate.
- Choose the induction coil: Once the heating requirements are determined, the next step is to choose the appropriate induction coil. The coil must be designed to generate the required magnetic field to induce eddy currents in the material being heated.
- Select the power supply: The power supply is responsible for supplying the necessary electrical energy to the induction coil. The power supply must be selected based on the heating requirements and the characteristics of the induction coil.
- Design the cooling system: An induction heater generates a significant amount of heat, which must be dissipated to avoid damage to the induction coil and other components. Therefore, a cooling system must be designed to maintain the proper operating temperature.
- Build and test the system: Once the design is complete, the induction heater must be built and tested. This involves assembling the components, connecting the

wiring, and running performance tests to ensure that the system meets the heating requirements.

- Fine-tune the system: Once the system is built, it may be necessary to fine-tune it to optimize performance. This may involve adjusting the coil design, changing the power supply settings, or modifying the cooling system.

Overall, designing an induction heater requires a thorough understanding of the heating application, the principles of electromagnetic induction, and the characteristics of the various components of the system. It is important to follow best practices and safety guidelines throughout the design and testing process to ensure that the induction heater operates safely and reliably.

2.7 OBJECTIVE

The objective of the design and implementation of an induction heater for maintaining the temperature of running water is to provide a heating solution that is:

- Efficient: The induction heater should be able to heat the water efficiently, reducing energy consumption and minimizing heat loss.
- Precise: The induction heater should be able to control the temperature of the water accurately, providing consistent and reliable heating.
- Safe: The induction heater should be designed with appropriate safety features to prevent electric shocks, overheating, and other hazards.
- Durable: The induction heater should be designed with high-quality components that can withstand the demands of the application and require minimal maintenance.
- Cost-effective: The induction heater should be designed with components and materials that are cost-effective and provide a good return on investment.
- Environmentally friendly: The induction heater should be designed to minimize its impact on the environment, such as reducing energy consumption and emissions.

- Compatible with the application: The induction heater should be designed to meet the specific requirements of the application, such as the flow rate, volume, and temperature range of the water.
- The objective of the design and implementation is to provide a reliable and sustainable heating solution for maintaining the temperature of running water that meets the specific needs of the intended application while ensuring safety, efficiency, and cost-effectiveness. Hot-water circulating systems generally provide convenience and save water, but have proven not be cost effective and expend large amounts of energy. Reduced energy consumption.

2.8 APPLICATION

The application of the design and implementation of an induction heater for maintaining the temperature of running water can be in various industries and settings, including:

- Food and Beverage Industry: In the food and beverage industry, induction heaters can be used to maintain the temperature of liquids during the manufacturing process, such as heating water for tea and coffee, maintaining the temperature of liquid chocolate, and heating milk for yogurt production.
- Industrial Processes: Induction heaters can be used in various industrial processes, such as maintaining the temperature of water used in heat treatment of metals, or maintaining the temperature of chemicals in chemical processing.
- Medical Settings: In medical settings, induction heaters can be used to maintain the temperature of fluids used in patient care, such as IV fluids.
- Laboratories: Induction heaters can be used in laboratories to maintain the temperature of various liquids used in experiments and tests.
- Domestic Use: Induction heaters can be used in homes to maintain the temperature of water for various purposes, such as for cooking, bathing, and cleaning.

Overall, the application of the design and implementation of an induction heater for maintaining the temperature of running water can be in any setting that requires a precise, efficient, and reliable heating solution for liquids.

CHAPTER – 3

PROJECT DESCRIPTION

3.1 EXISTING BLOCK DIAGRAM AND EXPLANATION

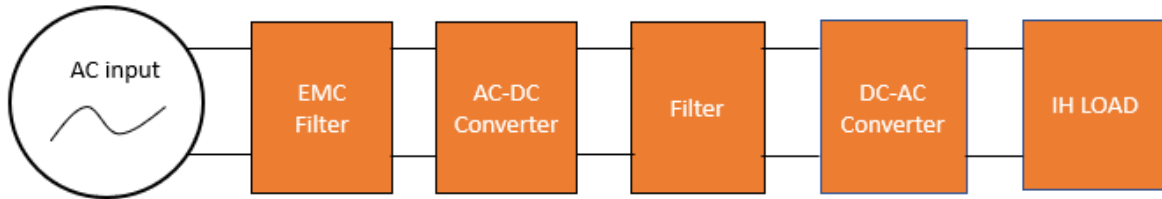


Fig:3.1 : Existing Block Diagram

(AC) input into direct current (DC) output. AC/DC Converters are also called “rectifiers”; they convert the input AC voltage to variable DC voltage, then optimize it through a filter to obtain an unregulated DC voltage. AC-DC converters are used in computers, televisions, cell phone chargers, and other electronic consumer devices. They are also used in medical, military, and telecommunications equipment; kitchen appliances; industrial machinery; and commercial products that use DC motors. AC-DC Converter given to filter a device that is used to remove something unwanted from a liquid or gas that passes through it. filter given to DC-AC Converter. An inverter is a device that changes direct current (DC) to alternating current (AC). Many devices that we use need more power to function than DC can provide. They're designed to operate on the 120-volt AC power supplied to homes in the U.S. AC power also works well at high voltages and can be increased by a transformer more easily than DC can. A power inverter, inverter or inverter is a power electronic device or circuitry that changes direct current (DC) to alternating current (AC). DC-AC Converter given to Induction Heater load.

3.2 DISADVANTAGE OF EXISTING SYSTEM

While induction heating has several advantages, there are also some disadvantages to consider, including:

- Induction heaters can be more expensive to purchase and install compared to other heating methods, which may not be feasible for some applications.
- Induction heaters are complex systems that require specialized knowledge and expertise to design, install, and maintain.
- Induction heaters may not be compatible with all types of containers or materials, as some materials are not suitable for induction heating.
- Induction heaters can produce noise during operation, which may be a concern in some settings.
- While induction heating is generally safe, there are some safety concerns that need to be addressed, such as the risk of electric shock and burns if not used properly.
- Induction heaters require regular maintenance to ensure they are operating efficiently and safely, which can add to the overall cost of ownership.

Overall, while induction heating has several advantages, it's important to consider the potential disadvantages before deciding on this technology for a specific application.

3.3 PROPOSED BLOCK DIAGRAM AND EXPLANATION

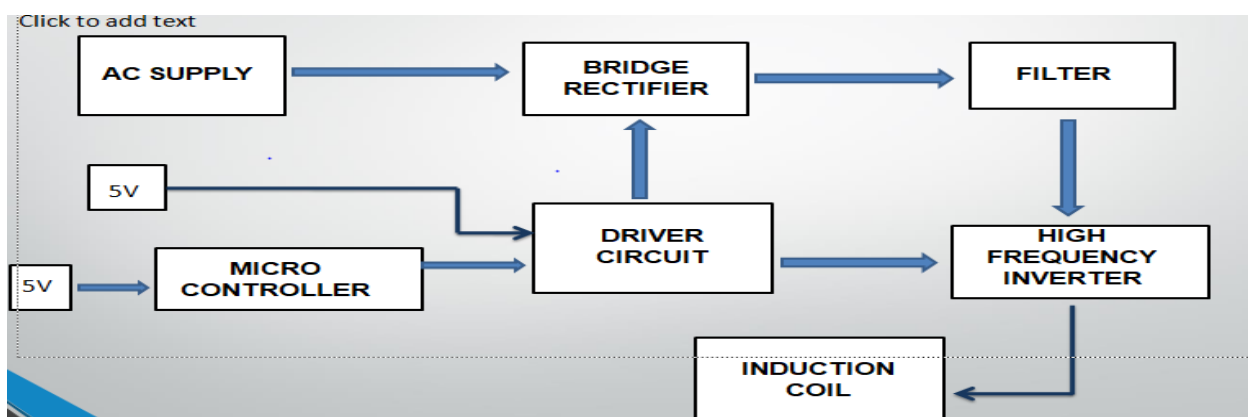


Fig:3.2 : Proposed Block Diagram

24v AC Supply given to bridge rectifier. Bridge Rectifiers use four diodes that are arranged cleverly to convert the AC supply voltage to a DC supply voltage it is connect to filter. Filters are systems or elements used to remove substances such as dust or dirt, or electronic signals, etc., Ripple remove filter .it is connected to high frequency inverter, High frequency power inverters typically convert the DC to AC by driving the transistors at a much higher frequency from 50 Kilo Hz to a few million Hz.5Vdc supply given to drive circuit. They are usually used to regulate current flowing through a circuit or to control other factors such as other components and some other devices in the circuit.5v dc supply given to micro controller. a compressed microcomputer manufactured to control the functions of embedded systems in office machines, robots, home appliances, drive circuit motor vehicles, and a number of other gadgets. micro controller connected to drive circuit connected to high frequency inverter. It is connected to induction coil it is produced magnetic flux the heat is formed then water converter to hot water.

3.4 ADVANTAGE OF PROPOSED SYSTEM

There are several advantages to the design and implementation of an induction heater for maintaining the temperature of running water, including:

- Induction heating is a highly efficient process that converts electrical energy into heat energy in the water directly, with minimal energy loss to the surrounding environment. This can result in significant energy savings compared to other heating methods.
- Induction heaters can provide precise temperature control, allowing for accurate and consistent heating of the water. This is particularly important in applications that require precise temperature control, such as in the food and beverage industry.
- Induction heating is a safe process that does not involve open flames or heating elements, reducing the risk of fire and other hazards. Additionally, induction heaters can be designed with safety features such as automatic shut-off to prevent overheating.

- Induction heaters are built with high-quality components that are designed to withstand the demands of the application and require minimal maintenance.
- Induction heaters are an environmentally friendly heating solution, producing less waste and emissions compared to other heating methods.
- Induction heaters can be used to heat a wide range of liquids, including water, and can be designed to meet the specific requirements of the application.

Overall, the design and implementation of an induction heater for maintaining the temperature of running water provides an efficient, precise, safe, and environmentally friendly heating solution that can be used in a variety of settings.

3.5 HARDWARE DESCRIPTION

An induction heater is an electrical device that uses electromagnetic induction to heat metal or other conductive materials. The device consists of several hardware components that work together to produce an electromagnetic field that heats the material.

The main hardware components of an induction heater are:

- **Power supply:** This component provides the electrical energy required for the induction heater to operate. The power supply may be a transformer or an inverter that converts AC power to high-frequency AC power.
- **Induction coil:** The induction coil is a copper coil that is wrapped around the material to be heated. When high-frequency AC current passes through the coil, it produces an alternating magnetic field that induces electrical currents in the material, causing it to heat up.
- **Capacitors:** Capacitors are used to store and discharge electrical energy in the induction heater. They help to stabilize the electrical current and prevent power spikes.
- **Control circuit:** The control circuit is responsible for regulating the power output of the induction heater. It may include sensors, microcontrollers, and other electronic components that monitor the temperature of the material being heated and adjust the power output accordingly.

- **Cooling system:** The induction heater generates a lot of heat, so a cooling system is required to prevent the components from overheating. The cooling system may consist of fans, heat sinks, or liquid cooling systems.

Overall, an induction heater is a complex electrical device that requires careful design and engineering to ensure reliable and efficient operation.

3.5.1. INDUCTION COIL



Fig: 3.3 : Induction Coil Design

The induction coil is a critical component of an induction heater, as it is responsible for producing the alternating magnetic field that induces electrical currents in the material being heated. The details of the induction coil can vary depending on the specific application and material being heated, but some general features include:

- **Coil shape:** The shape of the coil can vary depending on the geometry of the material being heated. Common coil shapes include cylindrical, rectangular, and helical coils.
- **Number of turns:** The number of turns in the coil can affect the strength of the magnetic field produced. Increasing the number of turns can increase the magnetic field strength, but it also increases the resistance of the coil.

- **Coil material:** The coil is typically made of copper wire or tubing, as copper is a good conductor of electricity and can withstand high temperatures.
- **Coil size:** The size of the coil can affect the efficiency of the induction heating process. A larger coil can heat larger objects, but it may require more power to produce the necessary magnetic field.
- **Inductance:** The inductance of the coil determines the frequency of the AC current that is produced. A higher inductance can produce a lower frequency AC current, while a lower inductance can produce a higher frequency AC current.
- **Tuning:** The coil can be tuned to the specific frequency of the power supply to maximize the efficiency of the induction heating process. This may involve adjusting the number of turns or the size of the coil.

Overall, the design of the induction coil is critical to the performance of the induction heater, and careful consideration must be given to its size, shape, and other parameters to ensure efficient and reliable operation.

3.5.2. THERMOMETER



Fig:3.4 : Thermometer

A thermometer is a device used for measuring temperature. There are various types of thermometers, but some of the most common types are:

- **Mercury thermometers** - These are traditional thermometers that use mercury to measure temperature. They are accurate and reliable, but have become less common due to the potential dangers of mercury.

- Digital thermometers - These use electronic sensors to measure temperature and display the results on a digital screen. They are easy to read and fast, but may require batteries.
- Infrared thermometers - These use infrared technology to measure the temperature of objects from a distance. They are non-contact and fast, but may not be as accurate as other types.
- Bimetallic strip thermometers - These use two different metals that expand at different rates when heated. The resulting movement of the strip is used to measure temperature.

The type of thermometer used depends on the application and the desired level of accuracy. For example, medical thermometers typically use digital technology, while industrial applications may require more specialized types of thermometers such as infrared or thermocouple thermometers.

3.6 IEEE STANDARDS OF THE PROJECT

The Institute of Electrical and Electronics Engineers (IEEE) has several standards related to induction heating. Some of the relevant standards are:

- IEEE 1655-2011: Standard for Induction Heating Equipment This standard provides guidelines for the design, construction, testing, and performance of induction heating equipment. It covers both static and dynamic heating systems and provides recommendations for the safe use of induction heating equipment.
- IEEE C95.1-2019: Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields This standard provides guidance on safe levels of human exposure to electric, magnetic, and electromagnetic fields. It is relevant for induction heating systems that generate high-frequency electromagnetic fields.
- IEEE 1723-2011: Recommended Practice for Measurement and Analysis of Electromagnetic Fields and Waves Associated with Electrically Conducting Objects This standard provides guidance on how to measure and analyze

electromagnetic fields and waves associated with electrically conducting objects, which includes induction heating systems.

- **IEEE 1241-2010: Guide for the Measurement of Partial Discharges in Rotating Machinery** This standard provides guidance on how to measure partial discharges in rotating machinery, which may include induction heating systems.
- **IEEE 446-2019: Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications** This standard provides guidance on the design, installation, and operation of emergency and standby power systems for industrial and commercial applications, including systems used to power induction heating equipment during power outages

These standards can be useful for ensuring the safe and effective operation of induction heating systems. It is important to consult the relevant standards and guidelines when designing, installing, and operating an induction heating system.

3.7 CONSTRAINTS IN THE PROJECT

There are several constraints that need to be considered when designing and operating induction heaters. Here are some of the most important ones:

- **Material Constraints:** Induction heating is most effective on materials that are good electrical conductors, such as metals. Non-conductive materials, such as ceramics and plastics, cannot be heated using induction heating.
- **Size Constraints:** Induction heating is most effective on small to medium-sized objects. Larger objects require more power and a larger induction heating coil, which can be difficult and expensive to design and manufacture.
- **Power Supply Constraints:** Induction heating requires a high-frequency AC power supply that can deliver a precise amount of power to the heating coil. The power supply must be able to handle the power requirements of the heating process and maintain a stable output voltage and frequency.
- **Cooling Constraints:** Induction heating generates a significant amount of heat, which can damage the heating coil and other components if not properly cooled.

Cooling systems, such as water-cooled jackets or fans, must be designed and installed to prevent overheating.

- **Safety Constraints:** Induction heating generates strong electromagnetic fields that can interfere with other electronic devices and pose a health risk to operators if not properly shielded. Safety measures, such as protective barriers, warning signs, and personal protective equipment, must be in place to ensure the safe operation of induction heating equipment.
- **Cost Constraints:** Induction heating equipment can be expensive to design, manufacture, and operate, especially for large-scale applications. The cost of the equipment must be carefully considered and balanced against the benefits of induction heating, such as improved efficiency and productivity.

These constraints need to be carefully considered when designing and operating induction heating systems to ensure they are effective, safe, and efficient

3.8 TRADE-OFF IN THE PROJECT

There are several trade-offs to consider when using induction heating:

- **Efficiency vs. Cost:** Induction heating is more efficient than traditional heating methods such as gas or electric heating, but it can be more expensive to set up and maintain.
- **Precision vs. Speed:** Induction heating can provide very precise heating control, but it can be slower than other heating methods. The trade-off between precision and speed needs to be considered depending on the specific application.
- **Size vs. Portability:** Induction heating coils and power supplies can be bulky and heavy, making them less portable than other heating methods. However, induction heating can be more space-efficient than other methods, making it ideal for applications with limited space.
- **Material Compatibility vs. Heating Capacity:** Induction heating is most effective on materials that are good electrical conductors. However, the capacity of the heating

equipment may be limited for some types of materials, such as those with high magnetic permeability or low electrical conductivity.

- **Power Output vs. Heat Output:** The power output of an induction heating system needs to be carefully balanced against the heat output to prevent damage to the heating coil and other components. This trade-off needs to be carefully considered when designing the system.
- **Safety vs. Efficiency:** Safety measures, such as protective barriers and personal protective equipment, can add to the cost and complexity of an induction heating system. The trade-off between safety and efficiency needs to be considered carefully to ensure the system is safe and effective.

Overall, the trade-offs associated with induction heating depend on the specific application and the requirements of the process. Careful consideration of these trade-offs is essential to ensure that the induction heating system is effective, efficient, and safe.

CHAPTER – 4

SIMULATION

4.1 Simulation For High Power Frequency Resonance inverter

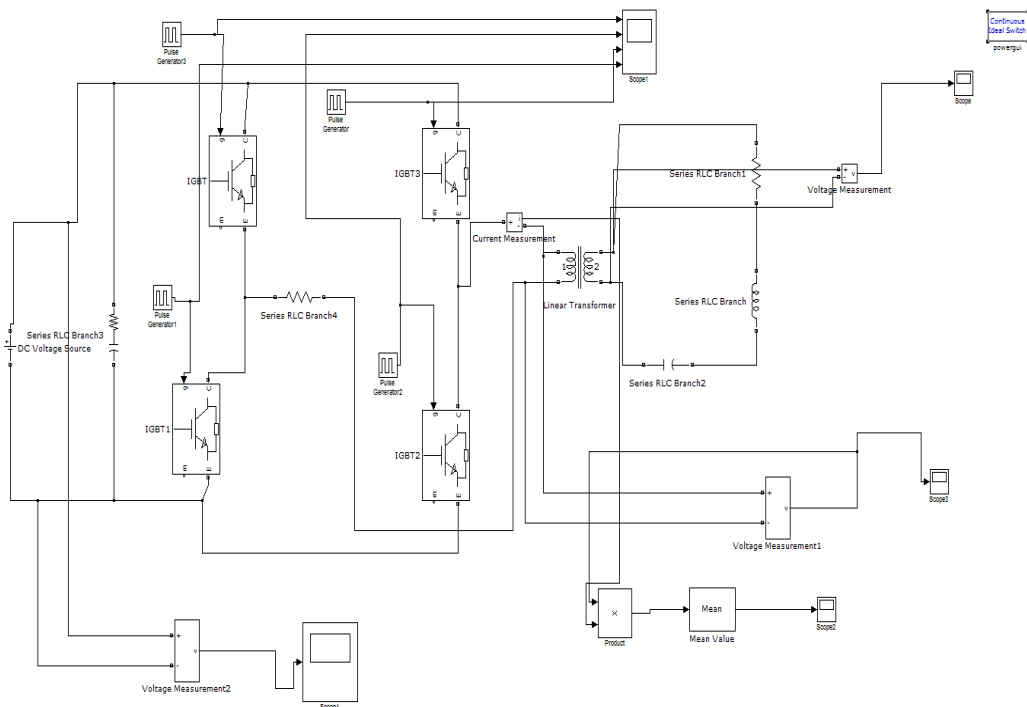


Fig:4.1 : Simulation For High Power Frequency Resonance inverter

We have done simulation by using mat lab. In this we have used components. Like IGBT, Resistance, Capacitor, Inductor, Transformer, Pulse, Scope, Voltage and Current measurement.

4.1.1 Simulation parameter for High Power Frequency Resonance inverter

S.NO	Parameter	Values
1	Input voltage	24
2	Switching frequency	26khz
3	Inductor	1000e-03
4	Capacitor	1500e-6
5	Transformer Rating	1.1 Isolation type
6	Resistance	0.0001

Table 4.1 : Simulation Parameter For High Power Frequency Resonance Inverter

4.1.2 Input Voltage

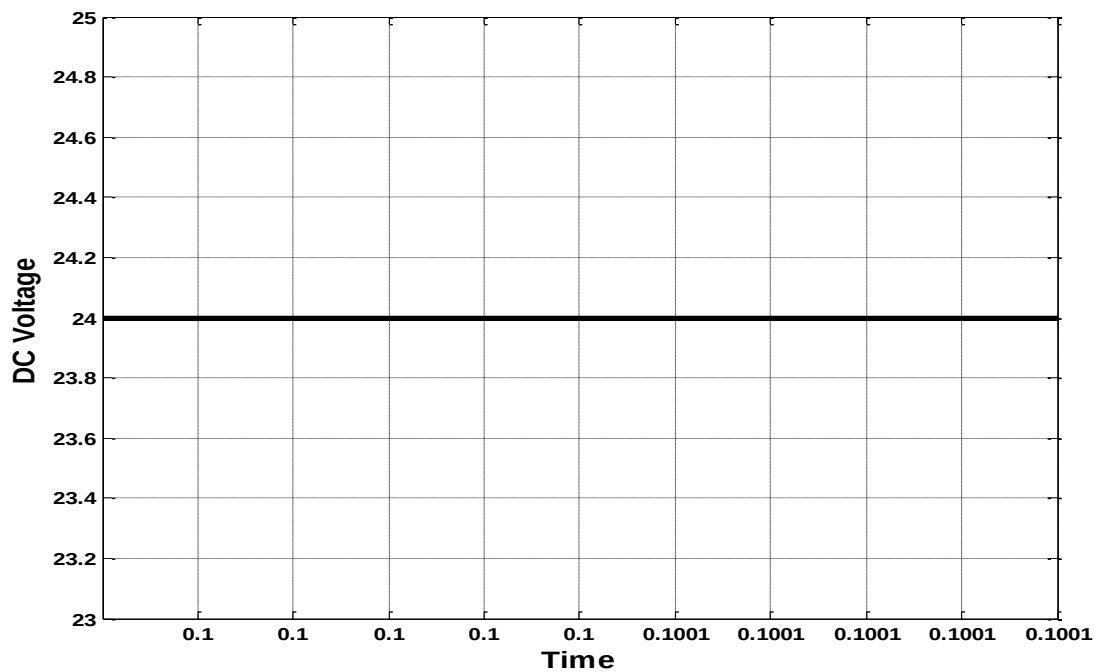


Fig:4.2 : Input Voltage

We have taken reference axis are Time in seconds and Primary Transformer. If Input given 24v the output we are getting 22v, the output is indicated like is Square wave form.

4.1.5 Secondary Voltage of Transformer

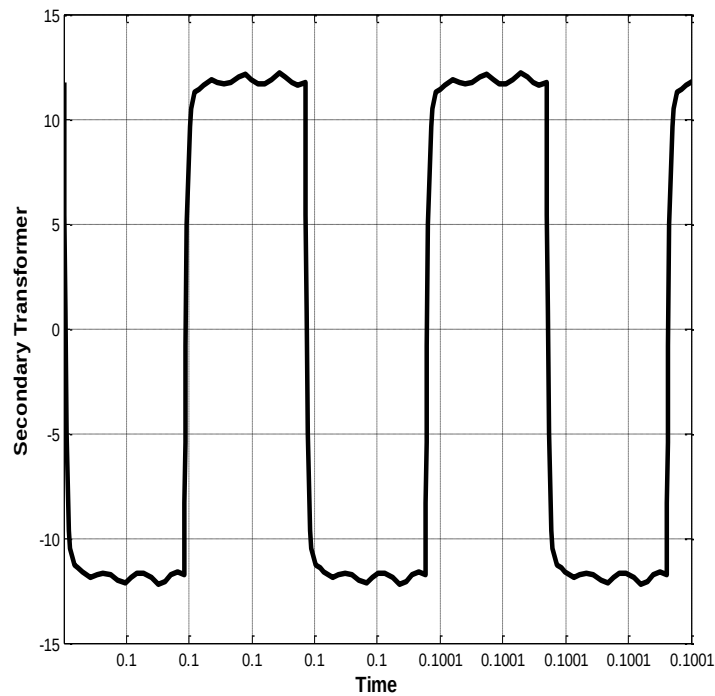


Fig:4.5 : Secondary Voltage of Transformer

We have taken reference axis are Time in seconds and Secondary Transformer. The output is indicated like is Sinusoidal wave form.

4.2 Simulation for Resonance Inverter

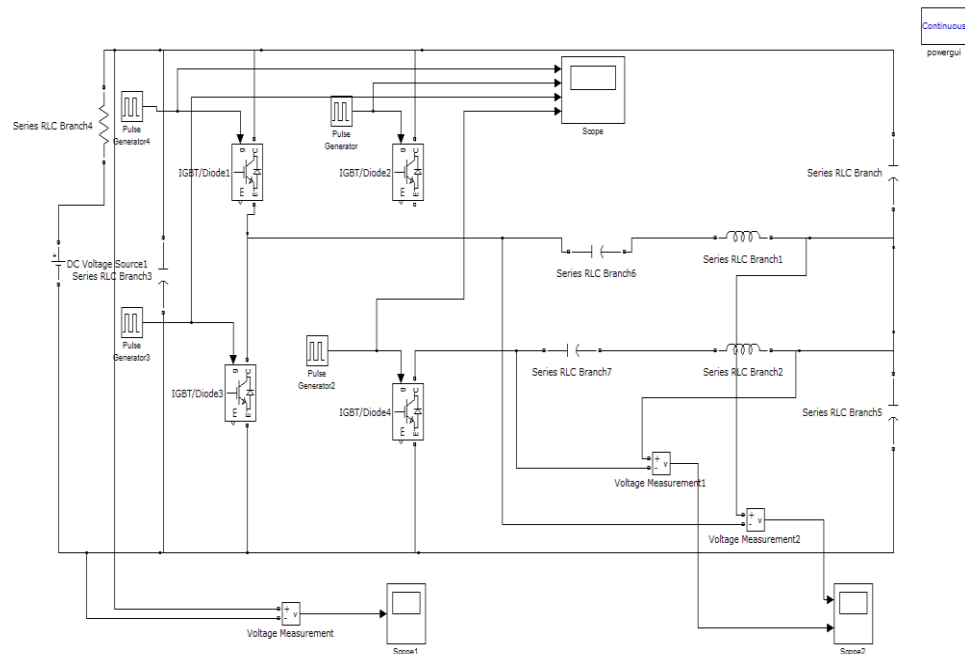


Fig:4,6 : Simulation for Resonance Inverter

We have done simulation by using mat lab. In this we have used components like IGBT, Resistance, Capacitor, Induction, pulse, Scope, Voltage and Current measurement.

4.2.1 Simulation parameter for Resonant Inverter

S.No	Parameter	Value
1	Input Voltage	24
2	Capacitor	100e-5
3	Inductor	100e-3
4	Switching frequency	50

Table 4.2 : Simulation parameter for Resonant Inverter

4.2.2 Input Voltage

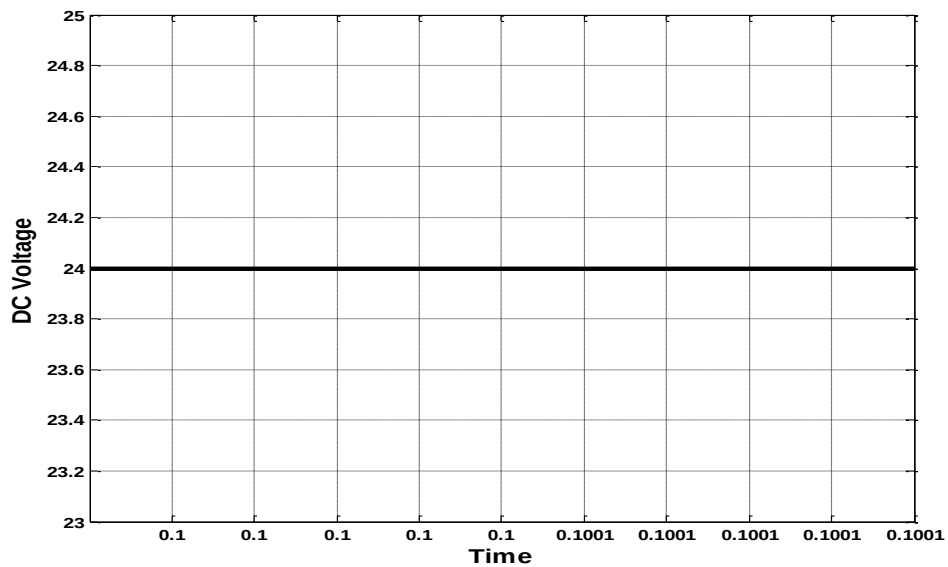


Fig:4.7 : Input Voltage

We have taken Reference axis are Time and Dc Voltage. we have given input is 24v, The output is indicated like is straight line.

4.2.3 Triggering Pulse To IGBT

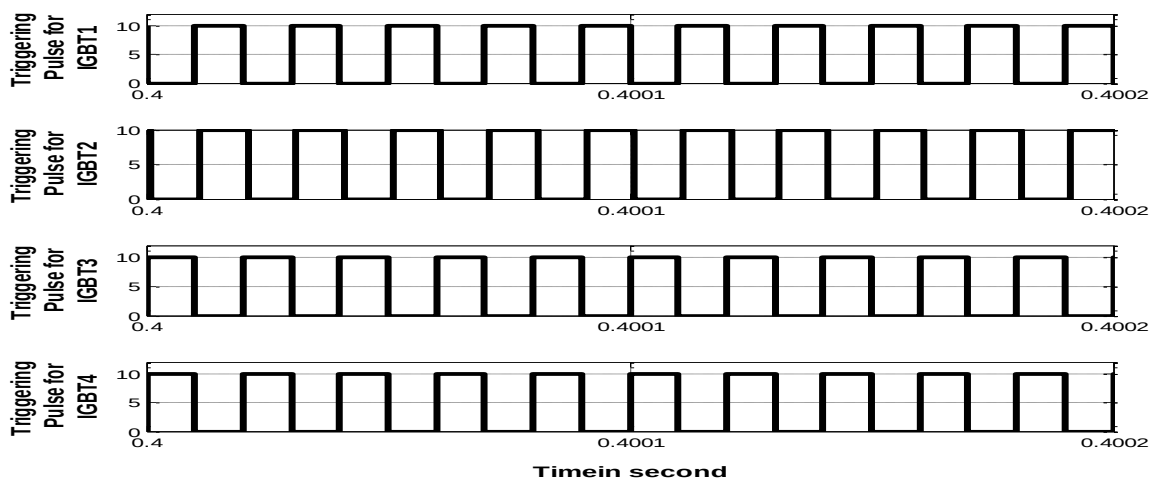


Fig:4.8 : Triggering Pulse To IGBT

We have taken reference axis are Time in seconds and Triggering Pulse for IGBT. The output is indicated like is square wave form.

4.2.4 Resonant Output Voltage

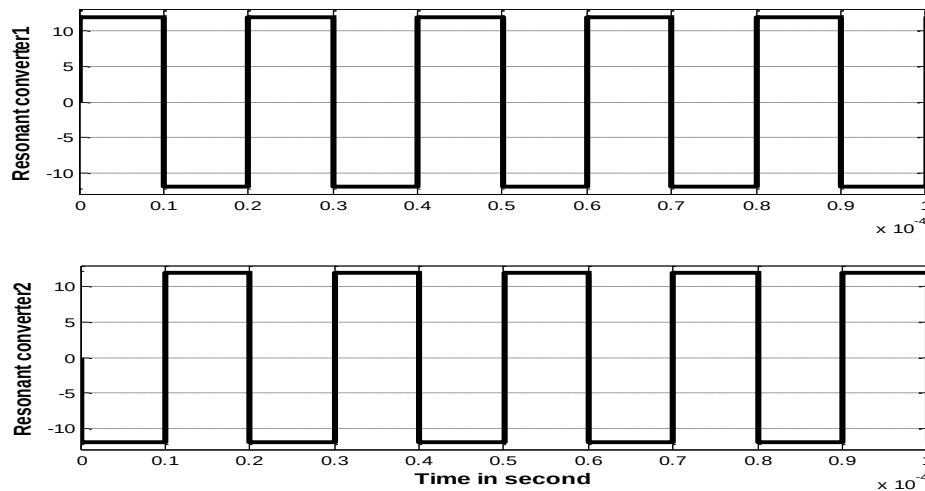


Fig:4.9 : Resonant Output Voltage

We have taken reference axis are Time in seconds and Resonant inverter. The output is indicated like is square wave form.

4.3 Simulation for Inveter with filter

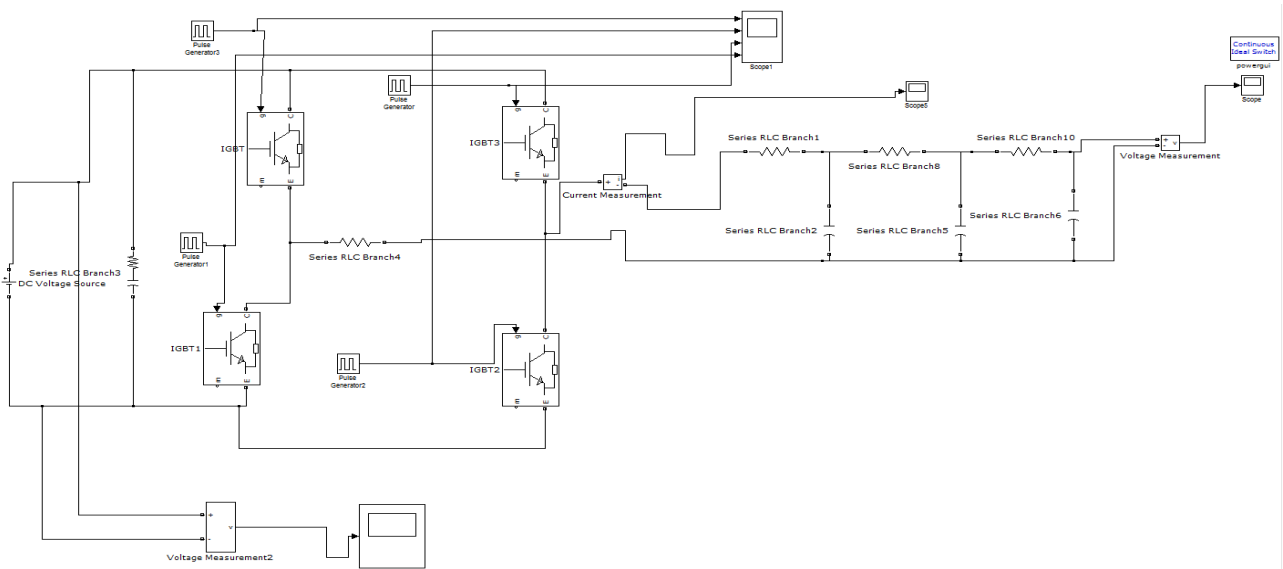


Fig:4.10 : Inverter with filter

We have done simulation by using Matlab. In this we have used components like IGBT,Resistance,Capacitor,Pulse,Scope,Voltage and Current measurement.

4.3.1 simulation parameter for Inverter with filter

S.NO	Parameter	Value
1	Input Voltage	24
2	Capacitor	4.7e-9
3	Resistance	100e3
4	Swiching Frequency	50HZ

Table 4.3 : Simulation parameter for Inverter with filter

4.3.2 FFT Analysis of Inverter

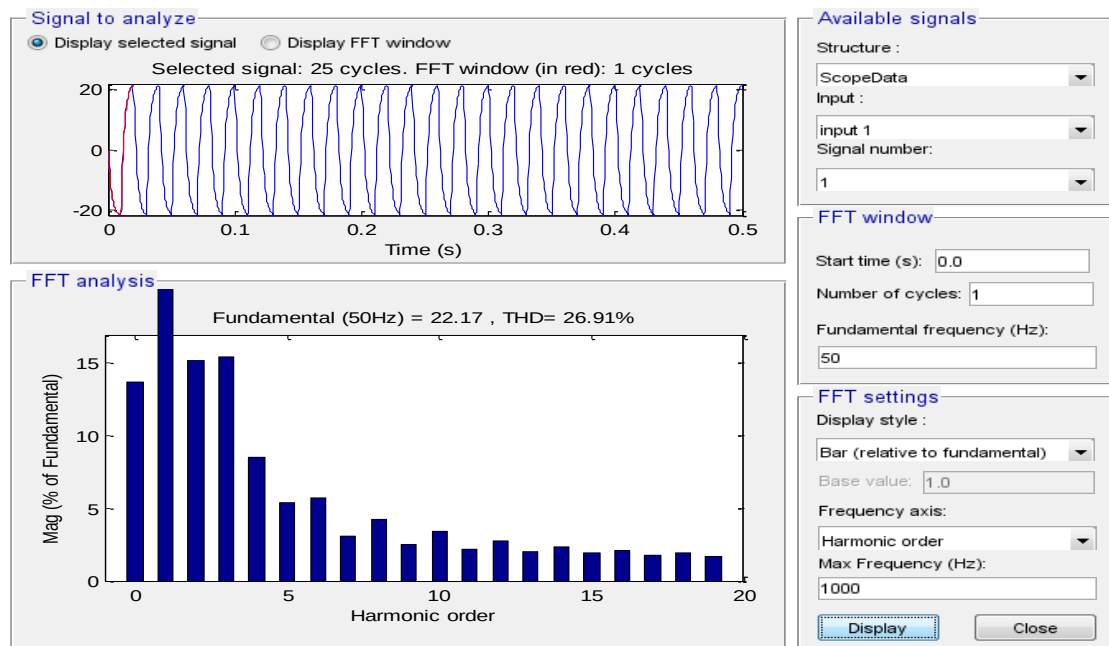


Fig:4.11 : FFT Analysis of Inverter

It has used the frequency is 50 hz . this THD value is 26.91

4.3.3 Input Voltage

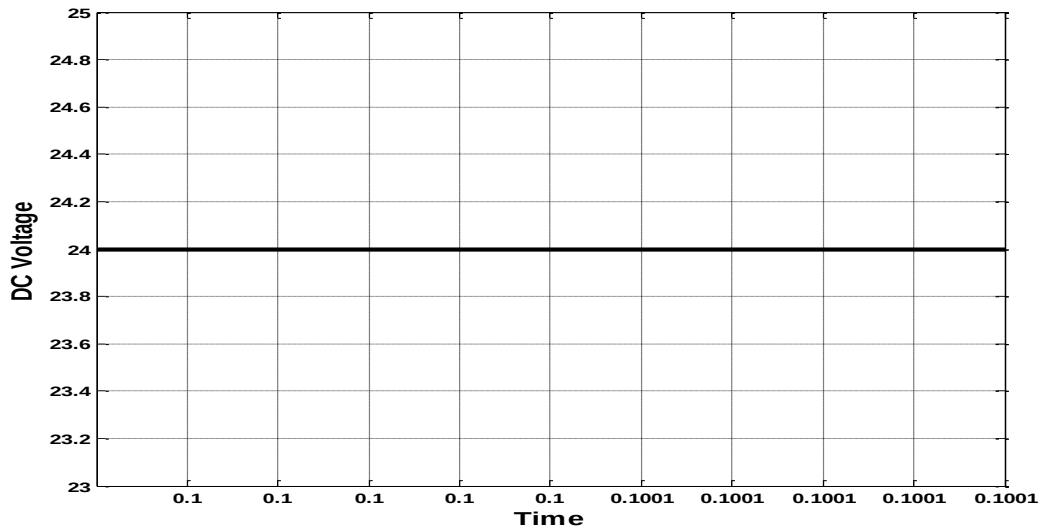


Fig:4.12 : Input Voltage

We have taken Reference axis are Time and Dc Voltage. we have given input is 24v.The output is indicated like is straight line.

4.3.4 Triggering Pulse for IGBT

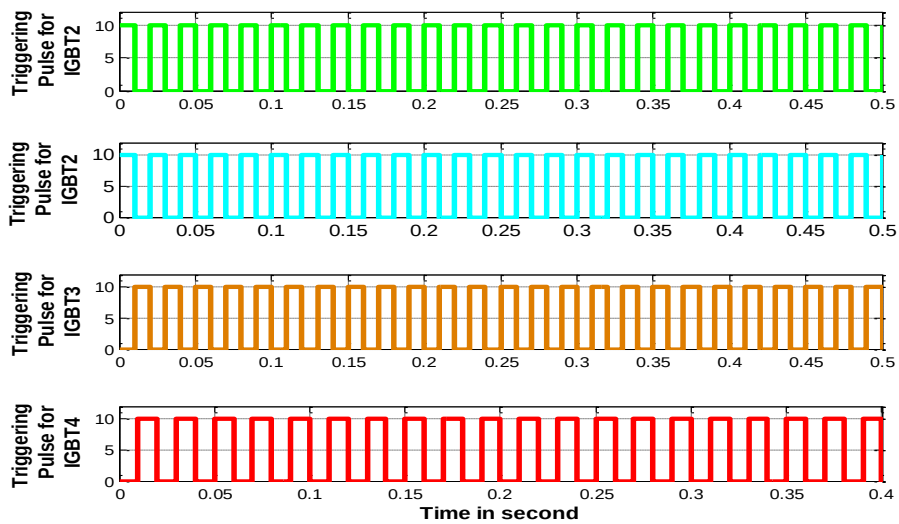


Fig:4.13 : Triggering pulse for IGBT

We have taken reference axis are Time in seconds and Triggering Pulse for IGBT. The output is indicated like is square wave form.

4.3.5 Inverter output voltage with filter

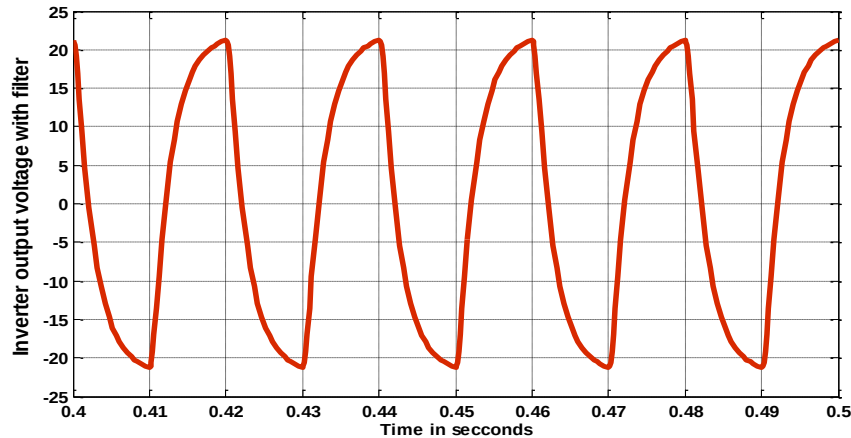


Fig:4.14 : Inverter output voltage with filter

We have taken reference axis are Time in second and inverter output voltage with filter. If input given 24v the output we are getting 21v. The output is indicated like is Sinusoidal wave form.

5.4 COMPARISON OF SIMULATION RESULTS

PARAMETER	HIGH POWER FREQUENCY RI	RESONANT INVERTER	INVERTER WITH FILTER
INPUT VOLTAGE	24	24	24
OUTPUT VOLTAGE	22	18	21
SWITCHING FREQUENCY	26KHZ	50KHZ	50HZ
THD	5000	3400	26.91

Table 4,4 : Comparision of simulation results

CHAPTER - 5

RESULTS AND DESCUSSION

5.1 Design of induction heater



Fig:5.1 : Design of Induction Heater

Induction heaters use electromagnetic induction to generate heat within a conductive material. The basic components of an induction heater include a power supply, a work coil, and a control circuit.

Here are the steps for designing an induction heater:

- Determine the power requirements: The power required for the induction heater will depend on the material to be heated and the desired heating rate.
- Choose the frequency: The frequency of the AC power supply used in the induction heater will determine the penetration depth of the magnetic field into the material being heated. The most common frequencies used in induction heating are 50-60 Hz and high frequency ranges from 1 kHz to 1 mhz.
- Determine the number of turns for the work coil: The number of turns in the work coil will depend on the frequency of the AC power supply and the size and shape of the material to be heated.

- Choose the core material: The core material is the material that the work coil is wrapped around. It is usually made of ferrite or iron powder.
- Design the work coil: The work coil is designed to generate a magnetic field that induces eddy currents in the material being heated. The design of the work coil will depend on the size and shape of the material to be heated.
- Build the power supply: The power supply is the component that generates the AC current that powers the work coil. It can be built using a variety of components, including transistors, diodes, and capacitors.
- Build the control circuit: The control circuit is used to regulate the power output of the induction heater. It can be built using microcontrollers or other programmable logic devices.
- Assemble the induction heater: Assemble the components into a functional induction heater, including the power supply, work coil, and control circuit.
- Test the induction heater: Test the induction heater to ensure that it meets the desired power requirements and that it is safe to use.

Designing an induction heater requires knowledge of electrical engineering, including circuit design and electromagnetic theory. It is recommended to consult with an experienced engineer or seek guidance from reliable sources before attempting to build an induction heater.

5.2 CALCULATION

Parameter of the workpiece

S.no	Parameter	Dimension
1	Diameter (D)	0.005m
2	Length (l)	0.29
3	Relative Permeability (μ_r)	1.003
4	Specific Heat (C)	490J/Kg.°C
5	Density (γ)	7500Kg/m ³
6	Resistivity (ρ)	6.9×10 ⁻⁷ Ωm

Table 5.1 : Parameter of the workpiece

Equivalent model of the workpiece placed in the coil

V_p = Primary Voltage(V)

I_p =Primary Current(A)

N_p = Number of primary turns

I_s = Secondary Current(A)

N_s = Number of secondary turns

V_s = Secondary Voltage(V)

R_L = Load Resistance

$$I_p N_p = I_s N_s$$

$$N_s=1$$

$$I_p N_p = I_s$$

Heat generated in the workpiece

$$P = I_s^2 R \text{ watts}$$

R is the Resistance path of the eddy current

$$P = (I_p N_p)^2 \pi \rho D / \delta l \text{ watts}$$

D = Diameter of workpiece

L = length of workpiece

δ =Skin depth

Area of cylinder = $\pi D l$

Surface Power

$$P_{sur} = P / \pi D l \text{ watts/m}^2 \quad \text{OR}$$

$$P_{sur} = (I_p N_p)^2 \pi \rho D / \delta l \cdot \pi D l \text{ watts/m}^2$$

$$P_{sur} = (I_p N_p)^2 \rho / \delta \text{ watts/m}^2$$

Skin depth

$$\delta = \sqrt{2\rho / \mu \omega} \text{ meters}$$

δ =Skin depth

ρ =Resistivity of the workpiece

μ =Magnetic permeability of workpiece

ω =Angular frequency of the varying magnetic field

$$P_{\text{sur}} = (I_p \quad N_p / l)^2 2\pi \rho \sqrt{\mu_r / \rho} \cdot 10^7 \text{ watts/m}^2$$

Magnetizing Force

$$H = I_p \quad N_p / l \text{ ampere.turn/m}$$

$$l = 1\text{m}$$

$$P_{\text{sur}} = 2\pi (H)^2 \sqrt{\mu_r \rho} 10^{-7} \text{ watts/m}^2$$

$$\mu_r = 1.003$$

$$F = 50 \text{ hz}$$

$$\rho = 6.9 \times 10^{-7}$$

$$P_{\text{sur}} = 2 \times 22/7 \times \sqrt{(1.003 \times 50 \times 6.9 \times 10^{-7})} H^2$$

$$P_{\text{sur}} = 0.03697555066 H^2 \text{-----(1)}$$

RELATIONSHIP BETWEEN POWER ,MEAN TEMPERATURE AND TIME

Energy in = Energy stored

$$\text{Energy In} = P_{\text{sur}} \cdot t \cdot (\text{Surface area})$$

$$\text{Energy stored} = \theta_m c \gamma \pi r^2 l$$

t = time

θ_m =temperature rise

C = specific heat

γ =density

r = radius

$$P_{\text{sur}} \cdot t \cdot (\pi D l) = \theta_m c \gamma \pi r^2 l$$

$$P_{\text{sur}} = \theta_m c \gamma R / 2t \text{ watts/m}^2$$

$$\theta_m = 50$$

$$C = 490\text{J/Kg.}^{\circ}\text{C}$$

$$\gamma = 7500\text{Kg/m}^3$$

$$R = 0.005\text{m}$$

$$T = 60\text{s}$$

$$P_{\text{sur}} = 50 \times 490 \times 7500 \times 0.005 / 2 \times 60$$

$$P_{\text{sur}} = 7656.25\text{watts /m}^2 \text{ -----(2)}$$

Equating Eq.1 and Eq.2

$$0.03697555066H^2 = 7656.25$$

$$H^2 = 207062.5$$

$$H = 455.04 \text{ ampere.turn./meter}$$

5.3 HARDWARE RESULTS

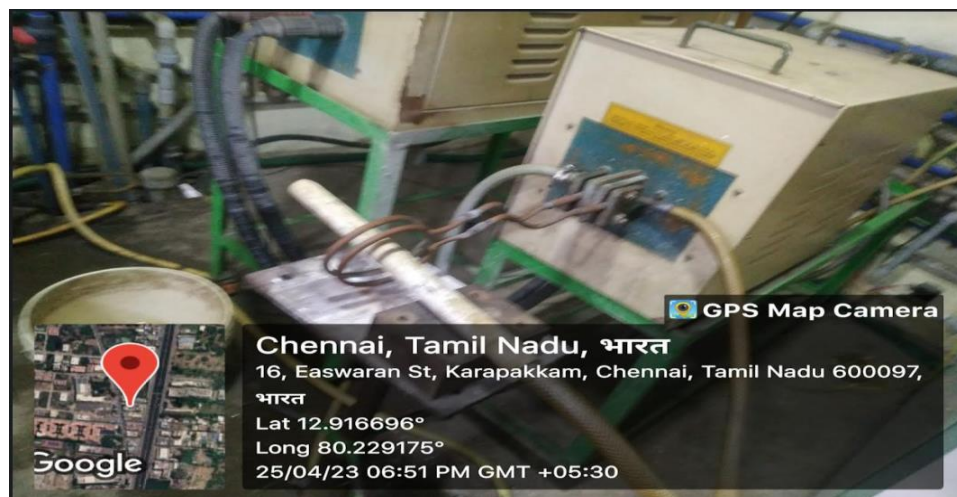


Fig:5.2 : coil design

An induction coil, also known as a Tesla coil, is an electrical device used to produce high-voltage, low-current, high-frequency alternating-current electricity. Here are the steps for designing an induction coil:

- Determine the operating frequency: The frequency of the induction coil determines the size and number of turns of wire needed for the coil. Generally, a higher frequency will require more turns of wire.
- Choose the core material: The core of the induction coil provides a path for the magnetic field. Common core materials include iron, ferrite, and air.
- Calculate the number of turns of wire: The number of turns of wire needed for the coil can be calculated using the formula $N = (L \times f \times 10^8)/(A \times B)$, where N is the number of turns, L is the length of the coil, f is the frequency, A is the cross-sectional area of the coil, and B is the magnetic flux density.
- Choose the wire gauge: The wire gauge should be chosen based on the current and voltage requirements of the coil.
- Wind the coil: Wind the wire around the core, making sure that each turn is tightly packed against the previous one.
- Add capacitors: Capacitors are used to tune the coil to the desired frequency. The value of the capacitors can be calculated using the formula $C = 1/(2\pi f^2 L)$, where C is the capacitance and L is the inductance of the coil.
- Test the coil: Once the coil is assembled, it should be tested to ensure that it is functioning properly. This can be done by connecting the coil to a power source and measuring the output voltage and current.

It's worth noting that designing an induction coil can be a complex process, and it's important to have a solid understanding of electrical engineering principles before attempting to build one.

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Fig:5.3 : Induction machine

An induction machine, also known as an asynchronous machine, is an electrical machine used for converting electrical energy into mechanical energy or vice versa. It operates on the principle of electromagnetic induction.

- There are two main types of induction machines: the induction motor and the induction generator.
- Induction Motor: An induction motor is a type of AC motor that converts electrical energy into mechanical energy. It consists of a stator and a rotor. The stator is the stationary part of the motor and contains the primary winding, which is connected to an AC power source. The rotor is the rotating part of the motor and contains the secondary winding, which is short-circuited. When an AC voltage is applied to the stator, a rotating magnetic field is generated, which induces a current in the rotor. This current produces a magnetic field that interacts with the stator magnetic field, causing the rotor to rotate.
- Induction Generator: An induction generator is a type of AC generator that converts mechanical energy into electrical energy. It operates on the same principle as an induction motor, but in reverse. When a prime mover, such as a wind turbine or hydro turbine, rotates the rotor of an induction generator, a rotating magnetic field

is produced. This induces a voltage in the stator winding, which generates an electrical current.

Induction machines are widely used in various applications such as in industrial machines, pumps, compressors, and household appliances. They are preferred over other types of machines because of their simple construction, low cost, and high reliability.



Fig:5.4: Hot Water

Hot water is water that has been heated to a temperature that is comfortable for human use, typically between 100-120°F (38-49°C). It is commonly used for bathing, cleaning and cooking.

- There are several methods for heating water:
- Electric Water Heaters: Electric water heaters use an electric heating element to heat the water. They are available in various sizes and can be installed either in a central location or at the point of use.
- Gas Water Heaters: Gas water heaters use natural gas or propane to heat the water. They are also available in various sizes and can be installed either in a central location or at the point of use.

- Solar Water Heaters: Solar water heaters use the energy from the sun to heat the water. They are typically installed on the roof of a building and can be either active or passive systems.
- Tankless Water Heaters: Tankless water heaters heat the water on demand, rather than storing it in a tank. They are typically more energy-efficient than traditional water heaters.
- Heat Pump Water Heaters: Heat pump water heaters use electricity to move heat from the air or ground to heat the water. They are typically more energy-efficient than traditional water heaters, but can be more expensive to install.
- When selecting a hot water system, it's important to consider factors such as the size of the household, the hot water demand, the energy efficiency of the system, and the cost of installation and maintenance.

CHAPTER – 6

CONCLUSION

6.1 SUMMARY

An induction heater is an electrical device that uses electromagnetic induction to heat metal or other conductive materials. It consists of several hardware components, including a power supply, an induction coil, capacitors, a control circuit, and a cooling system.

The power supply converts AC power to high-frequency AC power, which is sent to the induction coil. The induction coil is typically made of copper wire or tubing and is wrapped around the material being heated. When high-frequency AC current passes through the coil, it produces an alternating magnetic field that induces electrical currents in the material, causing it to heat up.

Capacitors are used to store and discharge electrical energy in the induction heater. The control circuit regulates the power output of the induction heater, adjusting the power output based on the temperature of the material being heated. The cooling system is required to prevent the components from overheating.

The design of the induction coil is critical to the performance of the induction heater, and factors such as coil shape, number of turns, coil material, coil size, inductance, and tuning must be carefully considered.

Overall, induction heaters are widely used in industrial applications for heating metal parts, welding, and soldering, among other uses, and they offer several advantages over traditional heating methods, such as faster heating times, better temperature control, and improved energy efficiency.

6.2 CONCLUSION

In conclusion, the induction heater is a powerful and versatile electrical device that has revolutionized industrial heating processes. Its ability to heat metal and other conductive materials quickly, efficiently, and with precise temperature control has made it a valuable tool in a wide range of applications, from welding and soldering to metal forging and heat treating. The hardware components of the induction heater, including the power supply, induction coil, capacitors, control circuit, and cooling system, work together to produce an electromagnetic field that heats the material being treated. The design of the induction coil is particularly critical, as it determines the efficiency and effectiveness of the heating process. Induction heaters offer several advantages over traditional heating methods, including faster heating times, better temperature control, and improved energy efficiency. They are also safer and cleaner than other heating methods, as they produce no open flames, noxious fumes, or toxic waste products. The heater's advantages and strengths that can be mentioned are: competitive and innovative design, water and electric energy saving system, it can be used in houses or hotels, generating comfort and benefits for the user. Its installation is relatively simple compared with its competence that works with gas, electricity or solar energy. Finally, the induction heater is a unique device that is the result of innovation and sustainable development, which has as objective to solve environmental and energetic issues. In this project, high-frequency resonant inverter circuit is practically introduced for IH appliances. The greatest advantage of this topology is a high-power density capability, which is obtained practically. The energy taken from the mains is filtered by an electromagnetic compatibility (EMC) filter, which prevents the device from inserting interferences and provides immunity to voltage transients. Then it is converted to DC using a rectifier

Overall, the induction heater is a powerful and innovative technology that has transformed the way we heat metal and other conductive materials. Its continued development and application will undoubtedly lead to even more significant advances in industrial heating processes in the years to come.

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